REMARKS

No claims have been amended. Claims 1, 7-10 and 46-52 remain pending in this application. Applicants reserve the right to pursue the original and other claims in this and other applications.

Previously, Applicants respectfully submitted that chemical vapor deposition (CVD), the process referred to in Kelly, Fong, and Henley, is a chemical process often used in the semiconductor industry for the deposition of thin films of various materials. In a typical CVD process, the substrate is exposed to one or more volatile precursors, which react and/or decompose on the substrate surface to produce the desired deposit. Frequently, volatile byproducts are also produced, which are removed by gas flow through the reaction chamber. CVD is widely used in the semiconductor industry to deposit various films as part of the semiconductor device fabrication process.

Atomic layer deposition (ALD), on the other hand, is a self-limiting, sequential surface chemistry that deposits conformal thin-films of materials onto substrates of varying compositions. ALD is a film growth technology that is capable of depositing uniform and conformal films with atomic precision. ALD is similar in chemistry to CVD, except that the ALD reaction breaks the CVD reaction into two half-reactions, keeping the precursor materials separate during the reaction. ALD film growth is self-limited and based on surface reactions, which makes achieving atomic scale deposition control possible. By keeping the precursors separate throughout the coating process, atomic layer control of film grown can be obtained as fine as ~ 0.1 angstroms per monolayer. ALD has an advantage over CVD in several areas, as ALD grown films are conformal, pin-hole free, and chemically bonded to the substrate (as is CVD). Therefore, ALD is distinct from CVD. Moreover, one of ordinary skill in the art would not look to a CVD process lacking the abilities of ALD to improve an ALD process.

The Office Action provides no response to the above. Applicants submit that the cited references, Kelly, Fong, and Henley, are not relevant to the claimed inventions because the processes taught by Kelly, Fong, and Henley are chemical processes and not self-limiting, sequential surface chemistry that deposits conformal thin-films of materials onto substrates of varying compositions. These are two separate and distinct types of gas phase deposition. One of ordinary skill in the art would not have looked to these chemical processes, which is necessary for a proper § 103(a) rejection, for various distinct features and to combine them in a manner to achieve the claimed ALD process. Nor does the Office Action, or the cited references themselves, provide a reason to the contrary. Thus, Applicants reassert its prior arguments from its prior papers, even in light of the new cited Boitnott reference (discussed below).

Claims 1, 7, 8, 10 and 49 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kelly (U.S. Patent No. 5,071,670) in view of Fong (U.S. Patent No. 5,935,334) and Boitnott (U.S. Patent No. 5,667,592). The rejection is respectfully traversed.

Claim 1 recites an atomic layer doping apparatus comprising "a central loading robot assembly for moving [the] first substrate back and forth between a first substrate holder in [the] first doping region laterally through [the] vertical inert gas curtain and a second substrate holder in [the] second doping region."

As previously argued, Kelly relates to a sequential CVD apparatus in a single reactor vessel 12. In particular, the reaction-containing pressure vessel 12 of Kelly consists of "[t]wo gas sources 14 and 16 [that] are contained within the interior of the vessel 12 and [which] direct their respectively different gases upwardly through gas emission plates 18 and 20." (Column 4, lines 13-16). In other words, the substrate in Kelly will be subjected to two distinct gaseous environments within the same doping

region without any physical barriers between the two environments (*See* column 4, lines 32-35), i.e., the vessel. This is contrary to the claimed invention where an inert gas curtain is provided between the two physically separate atomic layer doping regions to prevent the cross contamination of the first and second gas species. The claimed invention comprises two atomic layer doping regions whereas Kelly discloses only one.

Moreover, Kelly discloses a substrate plate that is rotated by a shaft in a counter-clockwise direction. (Kelly at column 5, lines 33-35). Kelly does not teach or suggest "a central loading robot assembly for moving [the] first substrate back and forth between a first substrate holder in [the] first doping region laterally through [the] vertical inert gas curtain and a second substrate holder in [the] second doping region" for at least two reasons. First, the substrate in the claimed invention is moved from one substrate holder to another and not rotated on a substrate plate. Secondly, the substrate plate of Kelly rotates in one direction, i.e., counter-clockwise, and not "back and forth between" doping regions. Thus, the Kelly structure and the claimed invention are completely different from each other.

Further, Kelly teaches that there are no physical barriers that separate the two environments e1 and e2 (FIG. 1; *see also* column 4, lines 28-35). Kelly refers to neither an inert gas curtain nor any other type of physical barrier. Hence, Kelly cannot disclose an atomic layer doping apparatus having "a vertical inert gas curtain" that chemically isolates the two atomic layer doping regions from each other. In the claimed invention, the structure comprises a physical barrier, i.e., a vertical inert gas curtain, that separates the first atomic layer doping region from the second atomic doping region.

In an effort to satisfy the shortcomings of Kelly, the Office Action combines Fong with Kelly. Fong is cited by the Office Action as teaching a first atomic layer region used for deposition and a second atomic layer region used for thermal diffusion

of the dopant species. However, even assuming the Office Action's statement regarding Fong to be true, which Applicants do not concede, Fong does not teach or suggest an atomic layer doping apparatus comprising "a first atomic layer doping region" and "a second atomic layer doping region, different from said first atomic doping region," where the two atomic layer doping regions are "chemically isolated from one another by a vertical inert gas curtain."

Moreover, Fong fails to teach or suggest "a central loading robot assembly for moving [the] first substrate back and forth between a first substrate holder in [the] first doping region laterally through [the] vertical inert gas curtain and a second substrate holder in [the] second doping region." In fact, Fong does not refer to any structure equivalent to "a central loading robot assembly."

The Office Action also attempts to cure the deficiencies of Kelly and Fong by combining them with Boitnott. As described above in regards to the other cited references, Boitnott relates to yet another chemical vapor deposition process and is believed to be no more relevant than the other cited references. Even if relevant, Boitnott would not cure the deficiencies of Kelly and Fong. The Office Action cites Boitnott as teaching separate susceptors in each of the reactor chambers and a loading assembly capable of moving a substrate back and forth between doping regions. (Office Action at 3). The loading assembly disclosed by Boitnott is nothing like the loading assembly claimed by the present application. Boitnott refers to an arm 24 that transfers wafers between the cassette 16 (outside of the apparatus) to the process station 31 (inside of the apparatus). See FIGS. 1B and 1C. A transfer carousel 30 is then used to oscillate the wafer between adjacent processing stations in a clockwise direction. Id. This is distinct from the claimed invention. In the claimed invention, the loading assembly moves a substrate "back and forth between a first substrate holder in [the] first doping region laterally through [the] vertical inert gas curtain and a second

substrate holder in [the] second doping region." The loading assembly of the claimed invention is not a rotating platform as is the carousel of Boitnott, and the loading assembly of the claimed invention is not limited to only moving in the clockwise direction as is Boitnott. Thus, the loading assembly of Boitnott does not render obvious the loading assembly of the claimed invention.

Therefore, Boitnott does not cure the shortcomings of the Kelly and Fong combination. For at least the reasons set forth above, Kelly, Fong and Boitnott do not, and cannot teach or suggest all limitations of claim 1. Nor would it have been obvious to one of ordinary skill in the art to combine the cited references to achieve the claimed invention. Claims 7, 8, 10 and 49 depend from claim 1 and should be allowable along with claim 1. Accordingly, Applicants respectfully request that the rejection be withdrawn and the claims allowed.

Claim 9 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Kelly, Fong, Boitnott and Henley (U.S. Patent No. 6,207,005). Claims 46 and 50 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kelly in view of Fong, Boitnott and Gattuso (European Patent Application No. 060626). Claims 47 and 51 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Kelly in view of Fong, Boitnott and Hartig (U.S. Patent No. 5,382,126). The rejections are respectfully traversed.

Claim 9 depends from claim 1 and thus recites the limitations described above. Claim 46 recites "a central loading robot assembly for moving [the] first substrate back and forth between a susceptor in [the] first doping region and a susceptor in [the] second doping region laterally through [a] substantially vertical inert gas curtain." Claim 47 recites "a central loading robot assembly for moving said first substrate back and forth between a first substrate holder in [the] first doping region and

a second substrate holder in [the] second doping region laterally through [a] vertical inert gas curtain."

For at least the reasons previously argued and those set forth above, Kelly, Fong and Boitnott fail to teach or suggest an atomic layer doping apparatus comprising a central loading robot assembly for moving the first substrate back and forth between a first substrate holder in the first doping region and a second substrate holder in the second doping region through a vertical inert gas curtain.

The Office Action combines additional references Henley, Gattuso and Hartig to cure the shortcomings of Kelly, Boitnott and Fong regarding certain additional claim limitations. However, Henley, Gattuso and Hartig have the same shortcomings as the other cited references. Henley is cited as teaching an apparatus comprising a third pair of atomic layer doping regions. Gattuso is cited as teaching an inert gas curtain provided at a higher pressure than the first dopant species. Hartig is cited as teaching a separate gas exhaust for each region in a multi-chamber coating apparatus. However, the cited references, Henley, Gattuso and Hartig, do not teach or suggest an atomic layer doping apparatus comprising a central loading robot assembly for moving the first substrate back and forth between a first substrate holder in the first doping region and a second substrate holder in the second doping region laterally through said vertical inert gas curtain as recited in the claims. Thus, the additional cited references do not cure the deficiencies of the Kelly, Fong and Boitnott combination and fail to teach or suggest all of the limitations of the claimed inventions. Nor would it have been obvious to one of ordinary skill in the art to combine the cited references to achieve the claimed invention. Therefore, claims 9, 46 and 47 should be allowable. Claim 50 depends from claim 46 and is allowable along with claim 46. Claim 51 depends from claim 47 and is allowable along with claim 47. Accordingly, Applicants respectfully request that the rejections be withdrawn and the claims allowed.

Claim 48 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Maeda (U.S. Patent No. 5,314,538) in view of Fong and Boitnott. The rejection is respectfully traversed.

Claim 48 recites an atomic layer doping apparatus comprising "a central loading robot assembly for moving [the] first substrate back and forth between a first substrate holder in [the] first doping region and a second substrate holder in [the] second doping region laterally through [a] closeable opening of [the] vertical physical barrier."

As previously argued, Maeda relates to a multi-processing apparatus consisting of three separate components. In particular, Maeda refers to an apparatus having a CVD reaction chamber for forming a film on a wafer and a heat-processing chamber. Contrary to the claimed invention, Maeda's apparatus is not capable of providing a plurality of atomic layer deposition reactor chambers. Maeda relates to a multi-processing apparatus having components including a single CVD reaction chamber and a heat-processing chamber. Thus, Maeda only refers to one reaction chamber. Maeda's apparatus is only capable of the single deposition region and a processing region (*i.e.*, heat-treatment region). Therefore, Maeda's apparatus does not teach or suggest first and second deposition regions.

Moreover, Maeda does not teach or suggest "a central loading robot assembly for moving [the] first substrate back and forth between a first substrate holder in [the] first doping region and a second substrate holder in [the] second doping region laterally through [a] closeable opening of [the] vertical physical barrier." In Maeda, the wafer holders are rotated around the rotary shaft in a plane by rotating a rotary shaft and rotates in a counter-clockwise direction. Maeda is not capable of moving "back and forth between" doping regions as in the claimed invention.

The Office Action seeks to overcome the deficiencies of Maeda by combining it with Fong and Boitnott. However, as previously articulated and described above, Fong and Boitnott add nothing to rectify the deficiencies of Maeda. Both Fong and Boitnott fail to teach or suggest an apparatus having a first atomic layer doping region, a second atomic layer doping region and "a central loading robot assembly for moving [the] first substrate back and forth between a first substrate holder in [the] first doping region and a second substrate holder in [the] second doping region laterally through [a] closeable opening of [the] vertical physical barrier."

Therefore, Maeda, Fong and Boitnott, whether considered alone or in combination, fail to teach or suggest all limitations of claim 48. Moreover, it would not have been obvious to one of ordinary skill in the art to combine the cited references to achieve the claimed invention. Accordingly, Applicants respectfully request that the rejection be withdrawn and the claim allowed.

Claim 52 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Maeda, Fong, Boitnott and Kelly. The rejection is respectfully traversed.

Claim 52 depends from claim 48 and thus recites the limitations discussed above in regards to claim 48. For at least the reasons set forth above, the cited combination of Maeda, Fong and Boitnott fail to teach or suggest an apparatus having a first atomic layer doping region, a second atomic layer doping region and "a central loading robot assembly for moving [the] first substrate back and forth between a first substrate holder in [the] first doping region and a second substrate holder in [the] second doping region laterally through [a] closeable opening of [the] vertical physical barrier."

The Office Action seeks to cure the shortcomings of the cited combination by combining it with Kelly. Kelly is cited as teaching reaction regions separated by an inert gas curtain. As discussed above, however, Kelly does not teach or suggest any of the shortcomings of Maeda, Fong and Boitnott. In other words, Kelly does not teach or suggest an apparatus having a first atomic layer doping region, a second atomic layer doping region and "a central loading robot assembly for moving [the] first substrate back and forth between a first substrate holder in [the] first doping region and a second substrate holder in [the] second doping region laterally through [a] closeable opening of [the] vertical physical barrier."

Accordingly, the cited combination of Maeda, Fong, Boitnott, and Kelly fails to teach or suggest all limitations of claim 52. Moreover, for at least the reasons set forth above, it would not have been obvious to one of ordinary skill in the art to combine the cited references to achieve the claimed invention. Applicants respectfully request that the rejection be withdrawn and the claim allowed.

In view of the above, Applicants believe the pending application is in condition for allowance.

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Respectfully submitted,

By _____

Thomas J. D'Amico
Registration No.: 28,371
Gianni Minutoli
Registration No.: 41,198
DICKSTEIN SHAPIRO LLP
1825 Eye Street, NW
Washington, DC 20006-5403
(202) 420-2200
Attorney for Applicant